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Analysis of Students' Numeracy Literacy Ability in Analyzing Graph and Table Information

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ABSTRACT

The ability to analyze information presented in graphs and tables is an important aspect of numeracy, as it is one of the indicators used to measure numeracy literacy internationally. This particular ability remains a challenge for students because it requires a high level of cognitive ability. However, it has not been extensively explored in depth. This study aimed to describe the difficulties encountered by tenth-grade senior high school students in analyzing information presented in the form of stacked bar charts and weekly expenditure tables. This study employed a descriptive qualitative approach. Initial data were collected through a numeracy literacy test consisting of one context-based problem involving a system of linear equations in three variables (SPLTV), which had been validated by an expert in mathematics education and used as an instrument for selecting the research subjects. The subjects were selected using purposive sampling. The selected subjects were then explored in greater depth through semi-structured interviews. The findings showed that, when analyzing information presented in graphs and tables, the participants experienced varying degrees of mathematical misunderstanding, ranging from a failure to coordinate the two representations, which resulted in strategic errors, to a gap between their understanding and their ability to solve mathematical problems. This study provides an empirical description of specific areas in which students experience difficulties with data-representation-based numeracy. The implication is that greater emphasis should be placed on instructional design that explicitly trains students to establish conceptual connections when solving problems.

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Introduction

In the era of globalization and rapid technological development, numeracy literacy skills are one of the fundamental competencies that must be possessed by every quality human resource. This ability not only includes skills in basic arithmetic but also includes an in-depth understanding of how mathematics works in everyday life (Gal et al., 2020). Numeracy literacy is closely related to the ability to think critically and reason and argue mathematically, formulate and solve problems and use representations, symbols, tools and technology (Sari et al., 2020; Mutmainnah et al., 2025; Anwar et al., 2021; Pratiwi et al., 2024). Therefore, individuals are not only required to be proficient in arithmetic but also able to use mathematics as a tool to solve problems in daily life.

The ability of numeracy literacy in Indonesia still shows a consistently worrying picture. The results of the assessment in 2022 show that Indonesia has an average score of 366 points ranked 69th out of 81 participating countries with a category that is still below the average of participating countries conducted by the *Program for International Student Assessment* (PISA) (OECD, 2023). Several previous studies have revealed the low level of numeracy literacy in Indonesia (Harahap et al., 2022; Jazilah, 2024; Wahyuni & Himmah., 2024). Therefore, the importance of numeracy literacy is emphasized through the Indonesian National Education policy by making it a minimum competency assessed in the Competency-Based National Assessment (ANBK) which has been implemented since 2021 (Rohim, 2021; Warman, 2023; Gafelina et al., 2026).

Numeracy literacy is one of the basic competencies measured in the Minimum Competency Assessment (MCA) and includes three main indicators, namely the ability to use numbers and mathematical symbols to solve contextual problems, the ability to analyze information presented in various forms of representation such as graphs, tables, and diagrams, and the ability to interpret the results of the analysis to make decisions (Han et al., 2017; Rosdiana et al., 2025; Yustitia et al., 2024). These three indicators are interrelated, because the ability to interpret and make decisions is highly dependent on the accuracy of students in reading and analyzing the data presented visually (Wardani et al., 2025)

The ability to analyze information presented in various forms of representation such as graphs, tables, and diagrams is used in measuring internationally assessed numeracy literacy (OECD, 2023) .This ability is the key needed by students to understand, evaluate, and use data critically in daily life, especially in data-based information in the digital era (Ritmayanti et al., 2025)However, not all students can interpret data well. Empirically, this ability is often a weak point for students caused by demands that require more complex cognitive processes than other indicators. Therefore, the low numeracy literacy of Indonesian students in PISA 2022 indirectly shows a weakness in this ability(Ozmen et al., 2020; Pallauta et al., 2021; Rufiana et al., 2024).

Based on the field results, according to the data of the education report card which shows that numeracy skills in schools are included in the good category with an achievement of 84,44%. However, this achievement has decreased by 6,67% compared to the previous year's achievements. This is in line with the results of PISA Indonesia which has decreased. The decline in achievement shows that there is a weakness in the quality of students' numeracy skills because numeracy is a competency that underlies students' ability to reason and solve problems using mathematical concepts in various contexts. The decline in numeracy achievement does not occur evenly, but in certain aspects, one of which is the level of reasoning competence (L3) which decreases compared to others.

The ability to analyze the information presented in graphs and tables is one of the indicators that is at the cognitive level of reasoning. Based on the results found in the field, students experience difficulties in these indicators, this can be seen based on school report card

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data showing that the achievement of the cognitive level the higher the cognitive level required in competence, the smaller the increase achieved, so that there is a decrease at the highest level. This pattern shows that there is a widening cognitive gap between abilities at the basic cognitive level and the high cognitive level. This is a strong basis for researchers to analyze these indicators as the focus of the study in this study.

Research on numeracy literacy has been extensively explored by various researchers (Fazzilah et al., 2020; Khomariah et al., 2022; Anggraini & Setianingsih, 2022). The research mostly focused on students' difficulties in the overall indicators of numeracy literacy in general, so that students' difficulties in certain indicators, namely reading, interpreting and analyzing data presented in graphs and tables have not been analyzed in depth. This condition shows that there is a gap between the breadth of numeracy literacy studies in general and the lack of studies specifically tracing students' difficulties in these indicators.

The novelty of this research lies in efforts to overcome these gaps by specifically targeting indicators to analyze information presented in the form of graphs and tables, which have not been explored in depth in the context of numeracy literacy. In contrast to previous research that tended to measure numeracy literacy as a whole. This research focuses on the difficulties of students in reading, interpreting and analyzing the data presented in graphs and tables in the material of the three-variable linear equation system (SPLTV). The graph used in this study is a stacked bar graph which is included in the uncertainty and data content in PISA. Based on a unique gap, this study was conducted to describe the difficulties of students in analyzing information presented in the form of stacked bar graphs and tables in the context of numeracy literacy. Therefore, a deeper understanding of the difficulties of students in integrating graph and table representations in numeracy literacy is obtained.

Method

Type of Research

This study employed a qualitative descriptive approach. This approach was used to provide an in-depth description of students' difficulties in analyzing information presented in the form of graphs and tables in the context of numeracy literacy. The cases studied and described represent a specific situation, namely students' errors in solving systems of linear equations with three variables. The results of this study apply only to the research subjects and cannot be generalized to other groups.

Subjects

The research subjects were selected through a numeracy literacy test administered to 22 tenth-grade students during the 2026–2027 school year. This test served as a screening tool to map variations in students' abilities, as well as the basis for subject selection through purposive sampling. Based on the results, two students who exhibited patterns of difficulty in coordinating multiple representations were selected as subjects for in-depth analysis. The process of selecting research subjects is illustrated in Figure 1. Scheme of The Research Subject Selection Process.

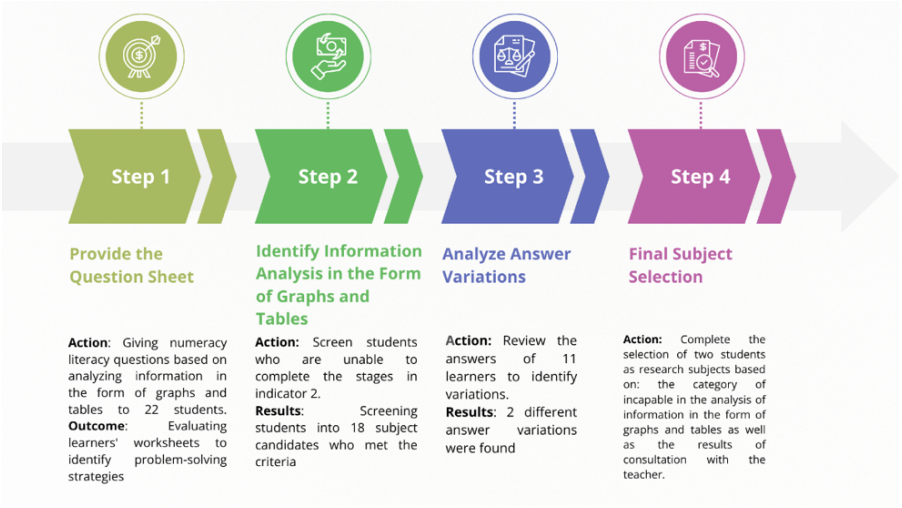


Figure 1. Scheme of The Research Subject Selection Process

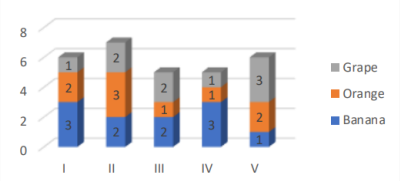
Based on Figure 1. Scheme of The Research Subject Selection Process, the research subject selection process was carried out through four systematic steps. Step 1 began by distributing a questionnaire to 22 students. Step 2 involves screening the students to select 18 potential subjects who are not yet capable of analyzing information presented in the form of graphs and tables. In Step 3, the responses of the 18 students are reviewed to identify variations in their answers, and two distinct variations are found. Step 4 involves selecting two students to be designated as research subjects based on their inability to analyze information presented in the form of graphs and tables, as well as the results of consultation with the teacher.

The final selection of subjects in Step 4 involved choosing two subjects to represent the 18 students who were unable to complete the analysis of the information presented in graphs and tables. This decision was made because all students provided the same answer, with only two variations. Therefore, selecting two subjects with the same answer was deemed sufficient for the analysis and presentation in this research article. Data collection was conducted through a numeracy literacy essay test designed to measure the ability to analyze information presented in the form of graphs and tables.

Instrument

This study used instruments in the form of a written numeracy literacy test and a semi-structured interview guide. The written test was designed based on indicators of numeracy literacy skills in analyzing information presented in the form of stacked bar graphs showing three categories of data simultaneously per week and expenditure tables, as well as the interview guidelines. The test instrument consisted of one essay question related to SPLTV and had been validated by a professor specializing in mathematics education. The written test question is shown in Figure 2.

Question Item: As part of a healthy lifestyle, Mrs.Diana and her family consume fruit. The quantity of fruit consumed each week is shown in the following graph.



Week	Total
I	*Rp* 180.000
II	*Rp* 255.000
III	*Rp* 205.000

If Mrs. Dian provides money Rp 1.000.000 for the preparation of the fruit buyer for 5 weeks, the amount of Mrs. Dian's shortfall of money is...

Figure 2. Numeracy Literacy Description Test Questions

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Based on Figure 2. Numeracy literacy description test questions used as a tool to determine the subject. The interview guidelines are compiled to delve deeper into the difficulties experienced by the subject. The guideline consists of 15 questions presented in Table 1.

Table 1. List of Interview Questions

No	Interview Questions
1.	Before working on this problem, have you ever seen a stacked bar chart like this? Has your teacher ever taught you how to read it?
2.	In this matter, what information did you get?
3.	What information does the stacked bar chart and table show in this question?
4.	In this question there are two pieces of information presented in graphs and tables. What do you think is the relationship between the two? Do graphs and tables convey the same or different information?
5.	How do you relate the numbers in the table to the parts on the stacked bar chart?
6.	From this question, you are asked to look for?
7.	In this question, asked to look for the lack of money, Mrs. Dian, what do you understand from the word lack? What mathematical operations are needed to look for flaws?
8.	Where did you get the information you wrote in this "known" section?
9.	In your answer, you wrote x:banana, y:orange and z:grape, why do you use the letters x,y,z? What do you want to do with those variables?
10.	What information does it use to find x, y and z values?
11.	Where do you get the figure of IDR 30,000 in each value of x, y and z?
12.	Why are the values of x, y and z divided equally? Is it appropriate to determine the values of x, y and z?
13.	Do you realize that every value should be different? As in daily life, the price of bananas should be cheaper than the price of grapes
14	You blanked the grade in week III, did you try to find the grade first before deciding to blank it? What happens when you try it?
15.	If you are now given the opportunity to improve your answers, where do you start?

Based on Table 1, the interview questions are organized based on three main areas: the initial understanding of graphs and tables, the interpretation and coordination of graphs and stacked bar tables, and the problem-solving and justification process.

Procedure

The research procedure consists of three stages: the preparation stage, the implementation stage, and the solution stage. Flow chart for the three levels as shown in Figure 3

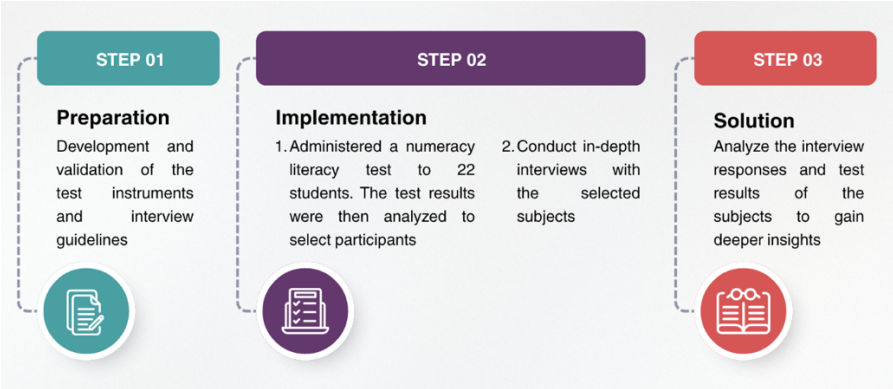

Figure 3. Research Procedure Flowchart

Based on Figure 3, the stages of this research procedure include: preparation of the first stage, which involves the development and validation of test instruments and interview

guidelines, the second stage of implementation, which involves giving tests to 22 students, analyzing the results to identify respondents, and conducting in-depth interviews with the subjects. The third stage involves analyzing interview responses along with respondents' test results to get a comprehensive picture of the difficulties they are experiencing.

Data Analysis

The data analysis used in this study consisted of data reduction, data presentation, and drawing conclusions to provide meaningful insights in the form of descriptions. To ensure the validity of the findings regarding the causes of the subjects' difficulties in analyzing stacked bar graphs and tables, the researcher used triangulation. The type of triangulation used in this study was methodological triangulation, which combined the results of numeracy tests with semi-structured interviews. To maintain the credibility of the findings, the researcher also conducted member checking by reconfirming the researcher's interpretations of the responses and interview data with the school's mathematics teachers to ensure their accuracy. Coding based on the results of the test description and the subject interview is presented in Table 2.

Table 2. Data Coding of Description and Interview Test Results

Data Code	Subject	Data Snippets	Subject Aspect	Category
W-S1-MD-01	S1	*"There is a stack chart with 3 different colors that indicates 3 different types of fruit and numbers in it and then there is the total expenditure in weeks 1, 2 and 3"*	MD	PB
W-S2-MD-01	S2	*"Types of fruit and lots of fruit on the graph and expense table in weeks I, II and III"*	MD	PB
W-S1-MAD-01	S1	*"If the graph shows the number of fruits and types of fruits, if the table shows the total expenses"*	MAD	PB
W-S2-MAD-01	S2	*"The information on the graph is bound to the information on the table. So the information in the table shows the total expenditure in the graph in weeks I, II and III"*	MAD	PB
TU-S1-MMD-01	S1	*"Write x=bananas, y=oranges, z=grape, then set x,y,z with Rp30,000 in week I"*	MMD	KM
TU-S2-MMD-01	S2	*"Write x banana = Rp 30,000, y orange = Rp 30,000, z grape = Rp 30,000"*	MMD	KM
W-S1-MMD-01	S1	*"I calculated that from the first week, the total expenditure was Rp 180,000 divided by 6 pieces with a result of Rp 30,000. So I consider the price of each fruit to be the same"*	MMD	KM
W-S2-MMD-01	S2	*"Actually I want to find the value of each fruit, I use the letters x, y and z because when I study I often use the letters x, y and z so I write x, y and z as a symbol of each fruit"*	MMD	KDP
W-S1-MMD-02	S1	*"I think it's right, because when I calculate it evenly like that, I get a round and easier value, so I think it's right for the x, t and z values."*	MMD	KDP
W-S2-MMD-02	S2	*"I immediately divided the total expenditure between the total expenditure and the total fruit in week I. Because I don't know any other way, if you divide it equally, you will get the value faster"*	MMD	KDP
W-S1-MMD-0W	S1	*"Oh yes, I just realized now, when I did it, I didn't think about it, you know."*	MMD	KM
W-S2-MMD-03	S2	*"I didn't think about it at that time, I just focused on getting the score first. But now I think it should be different."*	MMD	KM

Description:
TU : Description Test
W : Interview

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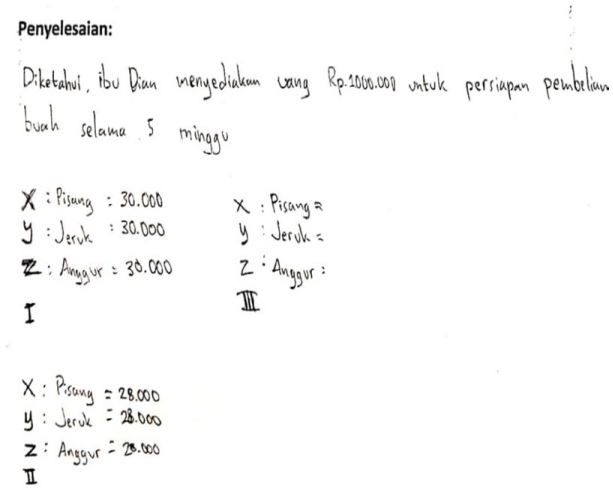
MD	:	Reading Data
MAD	:	Reading Between Data
MMD	:	Reading Beyond Data
PB	:	True Understanding
KM	:	Generalization Error
KDP	:	Declarative-Procedural Gap
KKR	:	Multiple Representation Coordination Failure

Research Findings

This study aims to conduct an in-depth exploration of students' abilities to read, interpret, and analyze data presented visually. It seeks to identify the factors contributing to students' difficulties while also providing a deeper understanding of the patterns in students' comprehension of numeracy literacy based on data representations. Data representation skills are crucial as a foundation for developing numeracy skills in subsequent stages of learning.

Based on the results obtained, the researchers identified findings regarding the ability to analyze information presented in the form of stacked bar graphs and tables in the material on systems of linear equations with three variables (SPLTV). These findings were derived from an analysis of the responses to the questions administered and were corroborated by interviews with the participants and follow-up discussions with the teachers. Of the 18 potential subjects who were unable to analyze the information presented in the form of graphs and tables, only two internal variations were identified; thus, two subjects were selected for in-depth analysis. Therefore, the selection of two subjects was deemed sufficient for the analysis and presentation in this research article. To facilitate the analysis process, the two subjects were coded as Subject 1 (S1) and Subject 2 (S2).

The results of the undergraduate students' work in the stage of analyzing information in the form of graphs and tables are illustrated by excerpts from their written answers, as shown in Figure 4.



Translate:
It is known that Dian's mother set aside Rp1,000,000 to prepare for purchasing fruit over a period of five weeks.

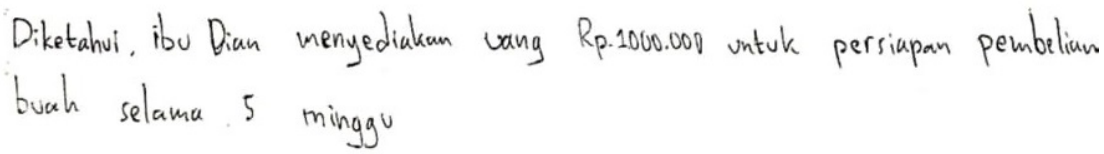
x: Banana = 30.000
y: Orange = 30.000
z: Grape = 30.000
I

x: Banana =
y: Orange =
z: Grape =
III

x: Banana = 28.000
y: Orange = 28.000
z: Grape = 28.000
II

Figure 4. Results of S1 Work in Solving Numeracy Literacy Problems

Based on Figure 4, S1's work in solving the numeracy literacy problem began with formulating the situation mathematically by identifying information regarding the amount of money to be divided over 5 weeks, as presented in the problem. S1's work in analyzing the problem is shown in the excerpt from the written response presented in Figure 4.



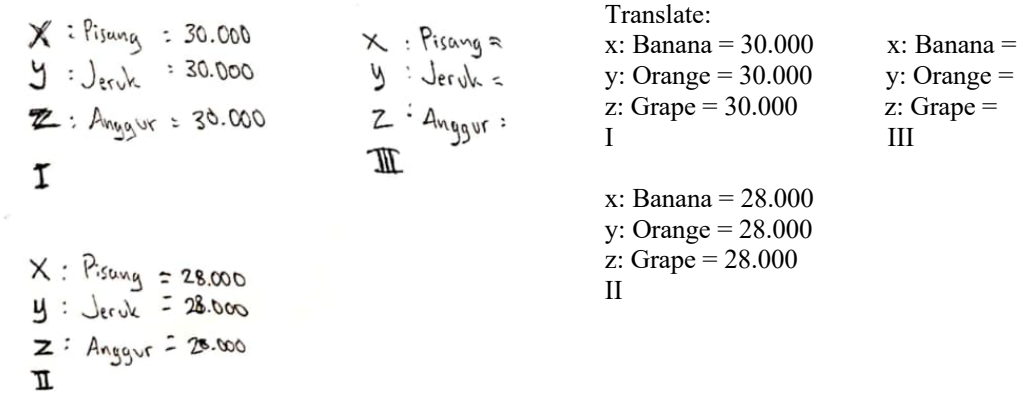
Translate:
It is known that Dian's mother set aside Rp1,000,000 to prepare for purchasing fruit over a period of five weeks

Figure 5. S1 Answers at the Stage of Identifying Questions

Based on Figure 5, S1 answer at the stage of identifying the question the researcher (P) conducted an interview with S1. Based on Figure 5. S1's response during the question-identification stage: the researcher (P) conducted an interview with S1:

P : *Where did you get the information you wrote in this "known" section*
S1 : *From the question at the bottom of the question before the question asked.*
P : *From this question, you are asked to look for?*
S1 : *Asked to find out the amount of money shortfall Mrs. Dian, kak.*
P : *In this question, there is any information that you get?*
S1 : *There is a stack chart with 3 different colors that indicates 3 different types of fruit and numbers in it and then there is the total expenditure in weeks 1, 2 and 3*
P : *In this question there are two pieces of information presented in the graph and table. What do you think is the relationship between the two? Whether the graph and table convey the same or different information?*
S1 : *No, if the graph shows a lot of fruits and types of fruits, if the table shows the total expenses.*

Based on Figure 5, S1's response during the question-identification stage, as well as the interviews conducted in stages, showed that S1 had recognized the explicit information in the problem; however, in the written test, S1 ignored the data on the number of fruits from the graph and the total expenditure data from the table. Next, S1 analyzed the information presented in the form of graphs and tables in the question, as shown in the student's written response presented in Figure 5.



Translate:
x: Banana = 30.000
y: Orange = 30.000
z: Grape = 30.000
I

x: Banana = 28.000
y: Orange = 28.000
z: Grape = 28.000
II

x: Banana =
y: Orange =
z: Grape =
III

Figure 6. Answer S1 on Analyzing Information in the Form of Graphs and Tables

Based on Figure 6Figure 6. S1's response during the analysis of the information presented in the form of graphs and tables, the researcher (P) conducted an interview with the subject (S1):

P : *In your answer, you write x: banana, y: orange and z: grape, why do you use the letters x, y ,z? What do you want to do with those variables?*
S1 : *I followed it like when I was learning algebra, if there are 3 types called x, y, z because there are 3 so I play each one with that letter. The plan is that I want to find the value of x, y, z as the price of the fruit.*
P : *To find x, y and z values, what information can be used?*

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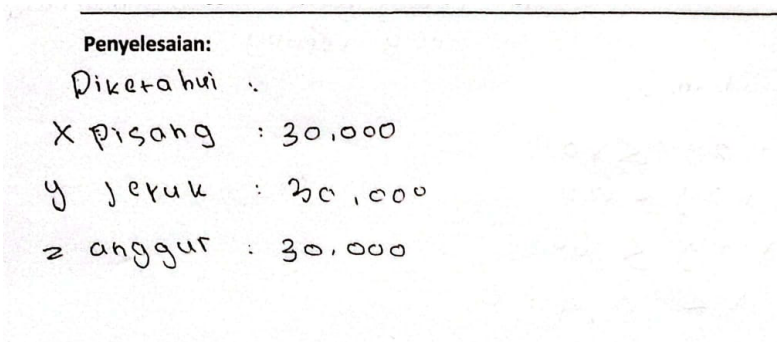
S1 : *Use the information in the graph as many fruits and in the table as the total expenditure*
P : *Where do you get IDR 30,000 in each value of x, y and z?*
S1 : *I calculated that from the first week, the total expenditure was Rp 180,000 divided by 6 pieces with a result of Rp 30,000. So I consider the price of each fruit to be the same.*
P : *Why are the values of x, y and z divided equally? Is that the right step to determine the values of x, y and z?*
S1 : *I think it's right, because when I calculate it by dividing it evenly like that I get a round and easier value, so I think it's right for the x, t and z values.*
P : *Do you realize that every value should be different? As in daily life, the price of bananas should be cheaper than the price of grapes?*
S1 : *Oh yes, I just realized right now, when I was doing it, I didn't think about it until I got there.*

Based on Figure 6, S1's responses regarding the analysis of information presented in graphs and tables, as well as the interviews conducted, it was found that when reading and interpreting the data presented, S1 was already able to identify during the interview that the graph served as a source of data on fruit and the table as a source of data on total expenditures. However, in the written test, it was found that Student 1 was unable to integrate the two representations presented in the question to construct a system of linear equations with three variables (SPLTV), resulting in Student 1 assigning the same value to each variable. Based on the above description, Student 1 exhibited a mathematical misconception caused by an inability to analyze information from graphs and tables.

Subject 2's (S2) performance in the stage of analyzing information in the form of graphs and tables is illustrated by excerpts from their written responses, as shown in Figure 7.



Translate:
x: Banana = 30.000
y: Orange = 30.000
z: Grape = 30.000
I

Figure 7. S2 Work Results in Solving Numeracy Literacy Problems

Based on Figure 7. As a result of S2's work in solving numeracy literacy problems, the researcher (P) conducted an interview with S2:

P : *From this question, you are asked to look for?*
S2 : *Looking for a lack of money Ibu Dian to buy fruit for 5 weeks*
P : *In this question, there is any information that you get?*
S2 : *Types of fruit and lots of fruit on the graph and expense table in weeks I, II and III*
P : *In this question there are two pieces of information presented in the graph and table. What do you think is the relationship between the two? Whether the graph and table convey the same or different information?*
S2 : *The information on the graph is bound to the information on the table. So the information in the table shows the total expenditure in the graph in weeks I, II and III.*

Based on Figure 7, S2's performance on numeracy literacy tasks and the interviews conducted in stages S2 was able to describe the relationship between graphs and tables. However, in the written test, S2 did not formulate the situation mathematically by identifying

the information presented in the problem. This indicates that S2 skipped the problem-formulation stage and proceeded directly to the execution stage without an adequate foundation. The following interview was conducted between the researcher (P) and S2:

P : *In your answer, you wrote x: banana, y: orange and z: grape, why do you use the letters x,y,z? What do you want to do with those variables?*
S2 : *Actually I want to find the value of each fruit, I use the letters x, y and z because when I study I often use the letters x, y and z so I write x, y and z as a symbol of each fruit.*
P : *What information can you use to find the values of x, y and z?*
S2 : *Total expenditure with a lot of fruit*
P : *Where do you get the number of IDR 30,000 in each value of x, y and z?*
S2 : *I immediately divide the total expenditure and the total fruit in the week I*
P : *Why are the values of x, y and z divided equally? Is it appropriate to determine the values of x, y and z?*
S2 : *Because I don't know any other way, if you divide it evenly, you will get the value faster.*
P : *Do you realize that every value should be different? As in daily life, the price of bananas should be cheaper than the price of grapes?*
S2 : *I didn't think about it at that time, I just focused on getting the grades first..*

Based on Figure 7, S2's performance in solving numeracy literacy problems and the interview regarding the analysis of information presented in graphs and tables it was found that during the interview, S2 was able to describe the relationship between the two. However, in the written test, it was found that S2 was unable to integrate the representations of both to construct a system of linear equations with three variables (SPLTV), resulting in S2 assigning the same value to each variable. Based on this analysis, S2 experienced a misconception caused by an inability to activate strategies when directly confronted with the problem.

Discussion

The results of this study show that both subjects (S1 and S2) began to be able to identify the purpose of the questions and write down the known information completely; however, neither was yet able to analyze the information presented in the form of stacked bar graphs and tables in an integrated manner, indicating that both subjects exhibited increasing misconceptions or misunderstandings. The misunderstanding that arose in the subjects lay in the stage of coordinating these two forms of representation, so that the information on quantity and price in the table was not accurately linked.

In the early stages, both subjects failed to coordinate the graph and the table as a single unit of information, thus treating the two sources of information as separate data sets. This failure was due to the underdeveloped ability to integrate specific representations to construct a system of equations. This is consistent with research (Ridha & Khairunnisa, 2025; Sumarni et al., 2023) showing that students struggle to transform narrative information into a correct system of equations. The subjects' failure in this study to coordinate representations led to errors in the application of problem-solving strategies, resulting in a tendency for subjects to treat results as uniform and to ignore differences in price quantities compared to the actual variables listed in the table. In the final stage, a gap emerged between the subjects' verbal understanding of the data and their ability to translate that understanding into a correct mathematical model.

The first trend indicates that both subjects generalized their results because they preferred to use simple arithmetic operations which they had mastered in previous grades as a strategy when faced with problems requiring a more complex analysis of the relationships between variables, without first constructing a model based on the quantity and price coefficients in the table. This pattern is consistent with the findings (Hariyani & Aldita, 2020; Rufiana et al., 2024) that procedural errors arise because students overlook some important information in the

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question when formulating a solution strategy. Therefore, the errors that occur are caused by students overlooking some important information in the question when formulating a solution strategy.

The second trend indicates that both subjects ignored the differences in quantity and price among the variables because the stacked bar chart visually displayed only the combined total without explicitly separating the values per variable; as a result, the subjects tended to treat these visual proportions as equivalent without verifying them against the detailed data in the table. Consistent with the findings of (Pallauta et al., 2021), this study shows that middle school students still struggle to accurately convert information presented in graphs into tabular form, with half of the study sample failing to construct a correct two-way table from a double bar graph. Therefore, this error is not merely a calculation error but reflects a failure at the transformation stage that is, the stage of converting information from a visual or tabular representation into a mathematical model that accurately reflects the relationships between the presented variables.

The findings regarding the inability to coordinate multiple representations in the early stages are consistent with (Hasanah et al., 2024; Ozmen et al., 2020), who state that elementary and middle school students tend to succeed in simple graph-reading skills but fail in higher-order skills such as interpreting graphs and drawing conclusions from them. This similarity confirms that students' difficulties do not lie in their ability to read data literally, but rather in their ability to process and connect that data into higher-order mathematical thinking structures. This indicates that the students have not yet been able to integrate the two representations to construct a system of equations. This is consistent with research (Ridha & Khairunnisa, 2025; Sumarni et al., 2023) indicating that students struggle with mathematization specifically, the inability to transform narrative information into a correct system of equations.

This study expands on the scope of (Pallauta et al., 2021), which focused on students' ability to convert information from one form of representation to another (from graphs to tables) in a static context. This study shows that more complex difficulties arise when students are required to coordinate two representations presented simultaneously within a single SPLTV problem context; thus, the task is not merely converting information from one form to another, but rather integrating two sources of information simultaneously to construct a single interconnected mathematical model. This expansion is important because it demonstrates that the difficulty of integrating dual representations can be more complex than the difficulty of translating single representations, which has been the focus of much previous research.

At the final stage of misunderstanding namely, the gap between verbal understanding and the ability to construct mathematical models these findings align with those of (Rufiana et al., 2024), who found that elementary school students made conceptual and procedural errors when solving numeracy literacy problems based on graphical representations, with a much higher proportion of procedural errors compared to conceptual errors during the data-reading stage. However, this study differs from those findings in terms of educational level and the complexity of the representations; it shows that the same errors even with more complex hierarchical patterns occur at the 10th-grade level when the representations presented consist of a combination of stacked bar graphs and tables simultaneously. This indicates that mastery of numeracy literacy based on dual representations does not automatically develop as students advance through educational levels but remains a persistent challenge if not explicitly practiced. This aligns with the findings of (Abidin & Mauliza, 2021), who emphasize that the ability to coordinate representations does not develop independently and requires scaffolding strategies to help students connect their knowledge.

Overall, based on the analysis of the information presented in the form of stacked bar charts and tables, both subjects experienced multi-level mathematical misunderstandings ranging from a failure to coordinate two representations, leading to strategic errors, to a gap between their understanding and their ability to solve problems mathematically caused by misconceptions in integrating graphical and tabular representations, which require structured support to build a correct understanding of representation integration. Subject misunderstandings are caused by having a misconception in integrating representations of graphs and tables that require structured help to build the subject's ability to relate information from different representations appropriately

Based on these findings, the implications in teacher learning need to apply scaffolding, a special exercise to compare and connect information from graphs and tables gradually and familiarize with problems involving multiple representations so that subjects not only read one form of information, but also can integrate two or more data sources. This strategy is important to help the subject curate misconceptions in connecting multiple representations and improve the ability to analyze information more independently. The unique aspects of this study provide a clearer picture of how both subjects struggled to analyze information presented in the form of stacked bar charts and tables. By situating these findings within the framework of numeracy literacy, this study offers practical insights for educators to bridge the gap between students' ability to interpret mathematical representations and their ability to construct mathematical models. This study is limited to two high school students in a specific problem context, which may affect the generalizability of the findings. Future research should be expanded to a larger sample and a wider variety of mathematical representations to validate and extend these results. Additionally, the development of assessment instruments based on dual representations could provide more systematic insights into the development of students' ability to integrate representations at the high school level.

Conclusion

Based on the results of the discussion and research described above, it can be concluded that students are able to identify the purpose of the questions and the information provided in its entirety. However, when analyzing information presented in the form of graphs and tables, students are not yet able to do so because they experience misunderstandings in integrating graphical and tabular representations; they require structured assistance to develop a correct understanding of how to integrate these representations. This study has several limitations, including the fact that it involved only two students as subjects, so the findings cannot yet be generalized to a broader population, and that it focused on only one problem context systems of linear equations with three variables (SPLTV) presented in the form of stacked bar graphs and tables so the difficulties identified may differ when applied to other types of graphs and tables or other mathematical problem contexts. Given these limitations, future research is recommended to investigate a wider variety of graphs and tables as well as problem contexts other than SLS, involving a broader range of participant characteristics to enhance the generalizability of the findings. Based on these findings, it is also recommended that future research emphasize the need for instructional designs that explicitly train students to recognize the functions of each representation and build conceptual connections among them within the context of numeracy literacy in everyday life

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Conflict of Interest

The authors declare that there are no conflicts of interest.

Auhor Contributions

A.N. contributes to understanding research concepts, data collection processes, and the preparation of original drafts. The other two authors (N.L and R.A) actively contributed to the preparation of the theoretical framework, the design of the methodology, the validation and the approval of the final manuscript. All authors state that the final version of this manuscript has been read and approved. The total percentage of contributions to the conceptualization, preparation and correction of this paper is as follows: A.N.: 60%, N.L.: 20%, R.A.: 20%.

Data Availability Statement

The authors state that the data supporting the results of this study will be provided by the corresponding author, [A.N.], upon reasonable request.

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